Acta Scientiarum. Animal Sciences
ISSN: 1806-2636
eduem@uem.br
Universidade Estadual de Maringá
Brasil

Mendes Ribeiro, Aline; de Oliveira, Maria Elizabete; Carvalho da Silva, Patrícia; de Oliveira Alves Rufino, Marcelo; Martins Rodrigues, Marcônio; Souza dos Santos, Maurílio
Canopy characteristics, animal behavior and forage intake by goats grazing on Tanzania-grass pasture with different heights
Acta Scientiarum. Animal Sciences, vol. 34, núm. 4, octubre-diciembre, 2012, pp. 371-378
Universidade Estadual de Maringá
.png, Brasil

Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1806-2636
ISSN on-line: 1807-8672
Doi: 10.4025/actascianimsci.v34i4.14544

Canopy characteristics, animal behavior and forage intake by goats grazing on Tanzania-grass pasture with different heights

Aline Mendes Ribeiro*, Maria Elizabete de Oliveira, Patrícia Carvalho da Silva, Marcelo de Oliveira Alves Rufino, Marcônio Martins Rodrigues and Maurílio Souza dos Santos

*Departamento de Zootecnia, Centro de Ciências Agrárias, Universidade Federal do Piauí, Campus da Socopo, s/n, 64049-550, Teresina, Piauí, Brazil. *Author for correspondence. E-mail: alinemendesribeiro@hotmail.com*

ABSTRACT. This study evaluated the influence of Tanzania-grass sward height (30, 50, 70 and 90 cm) on the morphological characteristics of the canopy, grazing behavior and forage intake by adult Anglo Nubian female goats. A completely randomized experimental design was employed, with two replicates in space and two replicates in time. Six animals were used to assess the grazing behavior, and four, the ingestion process. The rise in sward height increased the forage and leaf mass, the percentages of stem and dead material, and reduced the leaf stem^{-1} ratio. Above 50 cm there was an increase in grazing time and a decrease in leisure time. A positive linear correlation was detected between sward height and bite depth. The consumed forage mass, ingestion rate and daily intake were higher at 50 cm, indicating that the other heights reduced the intake process. The sward height was negatively correlated to the bite rate and positively to the bite time. The sward height of 50 cm presents the best combination of features, favoring the grazing and ingestive behavior of female adult goats.

Keywords: consumption, forage production, bite rate, ingestion rate, grazing time.

Características do dossel, comportamento animal e ingestão de forragem por caprinos em pasto de capim-tanzânia em diferentes alturas

RESUMO. Objetivou-se avaliar a influência da altura do pasto (30, 50, 70 e 90 cm) de capim-tanzânia sobre características morfológicas do dossel, comportamento em pastejo e processo de ingestão de forragem por cabras anglonubianas. Adotou-se o delineamento inteiramente casualizado, com duas repetições no espaço e duas repetições no tempo. Para a avaliação do comportamento em pastejo foram utilizadas seis cabras e do processo de ingestão, quatro cabras. O aumento na altura do dossel resultou em aumento na massa de forragem e de folhas, da porcentagem de colmo e material morto, e redução na razão folha colmo^{-1}. Acima de 50 cm ocorreu aumento no tempo de pastejo e diminuição no tempo de ócio. A correlação entre altura do dossel e a profundidade de bocados foi linear positiva. A massa de forragem consumida, taxa de ingestão e consumo diário foram maiores aos 50 cm, indicando que nas demais alturas houve restrição ao processo de ingestão. A correlação entre a altura do pasto e a taxa de bocados foi negativa e, positiva com o tempo por bocado. A altura de 50 cm apresenta melhor combinação de características que favorecem o comportamento em pastejo e ingestivo de cabras.

Palavras-chave: consumo, produção de forragem, taxa de bocados, taxa de ingestão, tempo de pastejo.

Introduction

The agricultural activity has been one of the major factors responsible for Brazilian economic growth (MARCELINO et al., 2006). In this context, the use of technologies to reduce risk and increase productivity will contribute to change the current profile of goat farming in Brazilian Northeast, from the extractivism to an income-generating activity.

Among technologies, the pasture is the most abundant food option with lower cost for producing animal protein for human consumption (MARCELINO et al., 2006). Worldwide, Brazil stands out as a livestock producer due to, among other factors, the exploitation of the productive potential of tropical grasses. These species have high accumulation rates of forage mass and when properly managed present structural characteristics and nutritional value consistent with a good animal performance (SILVA; NASCIMENTO JÚNIOR, 2007).

Panicum maximum stands out among improved species of tropical grasses introduced in the last two decades in Brazil, whose cultivars are among the main forage used, with high productivity and persistence under intensive management because of its high

photosynthetic and hydric efficiency, besides its extensive phenotypic plasticity, depending on the frequency of defoliation (POMPEU et al., 2008). In recent years, the Tanzania-grass (*Panicum maximum* cv. Tanzânia) became one of the main forages used in intensive systems of grazing livestock production (MARTHA JÚNIOR et al., 2004).

Studies on diverse tropical grasses revealed that management strategies based on limiting the canopy height allow an acceptable balance between the processes of forage production, define consistent responses from plant population to defoliation, reflect the variations in chemical and physical properties of the soil and climate, are easily measurable and allow understanding the effect of variations in canopy structure on the responses of plants and animal behavior (CARNEVALLI et al., 2001a and b; SBRISSIA et al., 2001, 2003). Furthermore, the canopy structure, especially in tropical forage, exerts direct effect on the process of ingestion and consumption of forage, by affecting the forage intake by the animal. In this way, the canopy characteristics, such as height, leaf density, leaf stem^{-1} ratio and proportion of dead material interfere with the consumption because alter the bite size, bite rate, and grazing time (GONÇALVES et al., 2009; PALHANO et al., 2007; REGO et al., 2006).

Most of these studies are made with sheep and cattle, whose diets are predominantly grasses. Differently, goats are selective generalist preferring broad-leaved species. The use of these cultivated pastures, formed by monoculture of grasses, in the feeding of these animals turns them into consumers of grasses with fewer opportunities of diet selection.

Thereby, understanding the dynamics of the grazing process and the activities performed by goats in these ecosystems is essential to define management practices that allow an effective forage intake.

The goal of this study was to evaluate the influence of the height of Tanzania-grass pasture on canopy characteristics, grazing behavior, processes of ingestion and consumption of forage by Anglo Nubian goats.

Material and methods

The experiment was conducted in the Sector of Goat Farming of the Department of Zootechny (DZO) from the Center for Agricultural Sciences (CCA) of the Federal University of Piauí (UFPI), city of Teresina, whose geographical coordinates are: latitude 05°05'21" S, longitude 42°48'07" W, and altitude of 74.4 m. The rainfall concentrates more than 70% in the months from January to April. According to Köeppen climate classification, the climate of Teresina is Aw', with dry winter and rainy summer, extending into the fall. The soil is classified as red-yellow Latosol. During the experimental period, August 2010 to January 2011, the temperature ranged from 29 to 38°C and the relative air humidity from 48 to 67% throughout the day. The experimental area (0.27 ha) consisting of Tanzania-grass was established in 2000, and since then it has been used by goats throughout the year, irrigated in the dry period, and fertilized annually with NPK (120-80-50 kg ha^{-1}).

Treatments consisted of four sward heights (30, 50, 70 and 90 cm), with two replicates in space (paddocks) and two replicates in time, totaling 16 assessment days, non-consecutive. The monitoring of sward height was made by means of measures at 2 days-intervals at 30 random points in each paddock, using a graduated scale (FAGUNDES et al., 1999), beginning after a standardization cut performed at 15cm from the ground. The canopy height corresponded to the average height of the curvature of upper leaves around the scale. As soon as the paddocks reached the desired height for the treatment, the animals were placed on pasture, where they remained from 7 to 17h, and being gathered into the fold by the end of the day. In order to evaluate the behavior on grazing, it was used six test-goats, and to assess the process of ingestion and consumption of forage, it was used four test-goats in each paddock, with adjustment of stocking rate.

To evaluate the forage mass and morphological characteristics of the canopy, we used PVC frames (1.0 x 0.5 m) to collect four samples per paddock, at 15 cm from the ground, the height set for post-grazing stubble. Samples were sent to Laboratory of Animal Nutrition (LANA) of DZO/CCA/UFPI, where they were weighted and subdivided into two samples, one to determine the forage mass, and another to separate into leaf, stem, and dead material. The material was weighed again and dried in air forced oven at a 65°C for 72h.Then we estimated the mass of forage and leaf, participation (%) of each component in the pasture and leaf stem^{-1} ratio.

With the aid of Field Scout® Quantum Meter 3415F, it was obtained the percentage of PAR (photosynthetically active radiation) intercepted by the canopy. The readings were made every evaluation day, at 12h, under clear sky, at 20 random points within each paddock, to obtain the radiation above the canopy (I0) and soon after this, with the equipment at ground level (I), to obtain the same reading below the canopy. The light interception was calculated using the equation: Interception = [(I0 - I) / I0] x 100.

The observations of behavior on grazing were done from 7 to 17h, every 10 minutes, being recorded in ethogram tables the activities (grazing, rumination, movement and leisure) performed by six adult dry goats with mean live weight (LW) of 40 kg and mean height of 70 cm. The forage supply was 6% of LW, with the use of other goats to adjust the load when necessary. Animals had water ad libitum and artificial shade. By the end of the day, when gathered into the fold, the animals had access to mineral salt. The bite depth was obtained by measuring marked tillers, through transects distributed to cover all experimental unit. At each paddock, 40 tillers were marked and weighed before and after the grazing. The bite depth was calculated by the difference in the measure of the extended tiller subtracted from the average of the lower height grazed (UNGAR, 1996).

The evaluation of the forage intake was performed by grazing tests, according to the method of double weighing proposed by Penning and Hooper (1985). It was used four adult dry goats with mean LW of 40 kg, which after fasting and liquid for 5h, were prepared with collector of feces and urine, weighed in 20 g precision balance and divided into two groups. The first one (animals A and B) was taken to the experimental area together with the animals evaluated for grazing behavior, for 45 minutes, and monitored by four evaluators working in pairs, each one evaluating one animal on the pasture, taking note of the number of bites and the actual time of feeding, with the aid of counters and manual stopwatch, whereas the second group (animals C and D) remained in adjacent area, under fasting, to determine metabolic losses (H_2O evaporation, loss and production of CO_2 and CH_4).

After 45 minutes, the animals were weighed again, ending the stage 1. Then, the second stage began, which occurred in a similar way to stage 1, but the animals A and B, which previously have had access to pasture, were conducted to the non-vegetated area to determine the metabolic weight loss; and the animals C and D were taken to the pasture, repeating the same previous procedures, ending the grazing test. The forage intake was calculated using the equation: $I = (W_2 + F + U + MWL) - W_1$, where I = forage intake; W_1 and W_2 = weight of the animals before and after the grazing; F = weight of feces; U = weight of urine; and MWL = metabolic weight loss. The result obtained was used to calculate the ingestion rate.

The ingestion rate (g DM minute^{-1} kg^{-1} LW) was determined by the ratio between the mass of total forage consumed per kg LW, and the actual time of feeding. The bite rate (bites minute^{-1}) was determined by the ration between the number of bites and the actual time of feeding, and the time per bite (seconds bite^{-1}), through the ratio between the actual time of feeding and the number of bites. The daily intake (DI) was calculated through the formula: DI = IR x DGT, where IR = ingestion rate and DGT = daily grazing time, obtained through the evaluation of the behavior on grazing.

We adopted a completely randomized design, with four sward heights, two replicates in time and two in space. The mean values of the characteristics of the pasture and of the behavior on grazing were compared by the Duncan's Test at 5% significance, and the data obtained for the forage intake were analyzed by means of regression analysis and correlation using the software SAS (2000).

Results and discussion

The level of DM of Tanzania-grass increased with the rise in canopy height, accompanied by the increase in FM and LDM, reflecting the effect of sward height management on the forage production for grazing animals (Table 1). The FM at 30 and 50 cm was equal to LDM at same heights, this because in this treatments 100% of the collected pasture consisted only of green leaves, i.e., 100% of live material, without DeM to 15 cm from the ground. The production of FM and LDM at 70 and 90 cm had differed due to the participation of other components, like stem and dead material. By evaluating the Tanzania-grass pasture, Rego et al. (2006), with heights ranging from 19.17 to 83.41 cm, and Silva et al. (2007), examining heights of 47.3, 64.0 and 76.1 cm, have obtained higher yields, between 2,770 and 6,320 kg DM^{-1} ha^{-1}.

At 70 cm, the pasture of Tanzania-grass had higher percentage of leaf, resulting in a greater L/S ratio than at 90 cm. The drop in the L/S ratio means a reduction in the nutritional value of available forage, as well as a loss for the grazing efficiency. The stem elongation, although intensifies the forage accumulation, compromises the canopy structure, decreasing its L/S ratio. Rego et al. (2001) observed growing participation of dead material for Tanzania-grass pasture at heights of 44, 57 and 75 cm, due to the greater shading in these treatments. According to these authors, this situation prevents the access of animals to the forage, mainly green leaves. By evaluating Tanzania-grass, Cano et al. (2004) observed that the increase in the canopy height promoted a quadratic effect in the DeM production, which increased up to the height of 60 cm, with a drop from this point.

Table 1. Level of dry mass (DM), forage mass (FM) and leaf dry mass (LDM), percentage of leaf, stem, dead material (DeM), leaf stem^{-1} ratio (L/S) and light interception (LI) of the Tanzania-grass pasture with different heights.

Heights	Characteristics							
	DM%	FM kg ha^{-1}	LDM kg ha^{-1}	Leaf %	Stem%	DeM%	L/S	LI%
30	22.1^{B}	470^{D}	470^{D}	100^{A}	0^{C}	0^{C}	-	88^{C}
50	30.4^{A}	1122^{C}	1122^{C}	100^{A}	0^{C}	0^{C}	-	94^{B}
70	33.2 ^{A}	2320^{B}	2090^{B}	89.9^{B}	6,9^{B}	3.1^{B}	13.5^{A}	97^{A}
90	33.8 ^{A}	3095^{A}	2525^{A}	52.3^{C}	9.8^{A}	7.7^{A}	9.2^{B}	97^{A}
CV	3.65	21.98	17.51	3.43	36.36	70.83	65.8	2.36

[1]Mean values followed by the same capital letters in the same column are not different ($p > 0.05$) by Duncan's test. *Coefficient of variation (%).

When analyzing the characteristics of Tanzania-grass, Silva et al. (2007) registered greater percentages of DeM, between 16.04 and 19.35%, and lower L/S ratios, between 3.70 and 7.75 at heights ranging from 47.3 to 76.1 cm, being the cuttings also performed to 15 cm height from the ground.

The LI increased with the rise in height, this because different canopy heights generate changes in the pasture structure, altering the light environment and resulting in canopy with different photosynthetic potential. No significant differences ($p > 0.05$) were found between the heights of 70 and 90 cm, when 97% of photosynthetically active radiation was intercepted by the canopy. The self-shading associated with stem elongation intensifies the senescence process and death of older leaves and even of tillers. The positive association between sward height and LI is well described for temperate grasses, and it has also been verified for tropical grasses, such as mombaça-grass (CARNEVALLI et al., 2006) and Tanzania-grass (BARBOSA et al., 2007). These latter observed that the conditions of 90, 95 and 100% of LI were achieved with canopy heights around 60, 70 and 85 cm, respectively, whereas Gomide et al. (2007), when evaluating heights up to 117.2 cm of mombaça-grass pasture, have obtained maximum LI of 96.4%, similar to observed in this study at 90 cm of canopy height, i.e., under experimental conditions, it was achieved higher LI at heights lower than reported by other authors.

No significant difference ($p > 0.05$) between grazing times at 30, 70 and 90 cm, with the shorter grazing time ($p < 0.05$) recorded at 50 cm (Table 2). At this height, we observed that the animals moved easily within the pasture, with ease to handle the bites (seizing and chewing). At 70 and 90 cm, the sward height had hampered to grab the forage, increasing the time spent on grazing. Besides that, the leaf blades undergo significant change according to sward structure, becoming more scattered at higher canopy heights, which can make difficult its capture during the grazing, reflecting in an increase in time to form the bite. Contrastingly, at 30 cm the sward was very short, which also hampered the grazing due to the low forage mass, increasing the time of search and seizure of food. Moreover, under situation of lower forage mass, the animals tend to compensate the ingestion by increasing the grazing time.

By evaluating the goat behavior on pasture of *Brachiaria hibrida* cv. Mulato under two levels of forage supply, 4 and 8% LW, Barros et al. (2007) registered longer time spent on grazing for the higher sward height that corresponded to the higher supply of forage.

The rumination time was short for all treatments. There is usually a rumination time after each grazing period, but most of rumination occurs during the night (PARENTE et al., 2005). The time spent for rumination increased for the 70 and 90 cm due to the greater amount of forage seized by bite and larger fractions ingested, besides characteristics related to nutritional value of the pasture, like higher content of fibrous component in the other heights. Shorter times of movement can be explained by homogeneity in the environment. In this case there is low complexity in the amount of information that the animal should have to activate its decision mechanisms, without need to search for diverse and more palatable food, since the sward consists of only one forage species (GONÇALVES et al., 2009). At 90 cm, we observed a longer time of movement due to search for potential bites, which reflect in longer time on grazing.

Table 2. Time (h) spent on grazing, rumination, movement and leisure of Anglo Nubian goats on Tanzania-grass pasture with different heights.

Heights (cm)	Activity (h)			
	Grazing	Rumination	Movement	Leisure
30	6.20 ^{A1}	0.25 ^{B}	0.26 ^{B}	3.27 ^{B}
50	5.30 ^{B}	0.45 ^{AB}	0.23 ^{B}	4.00 ^{A}
70	6.09 ^{A}	0.60 ^{A}	0.24 ^{B}	3.05 ^{BC}
90	6.33 ^{A}	0.54 ^{A}	0.46 ^{A}	2.65 ^{C}

[1]Mean values followed by the same capital letters in the same column are not different ($p > 0.05$) by Duncan's test.

The longer leisure time was verified for the 50 cm height, when the animals spent a shorter time on grazing. In all evaluated heights, the goats spent most of the day on grazing; being the leisure the second most frequent activity. Other studies also reported this pattern of behavior (BARROS et al., 2007; PARENTE, et al., 2005). During the leisure period, the animals remained longer time standing still or lying on the grass.

Several peaks of grazing were observed, the most intense in early morning, with several lower peaks distributed throughout the day. The rumination peaks were concentrated soon after the grazing peaks. In the activity of displacement the animals have visited all the paddock area, creating in most of times corridors along the fences.

The animals remained in leisure during the hottest times and by the end of the day, when they seemed to be filled, reflecting the effect of sward height and weather conditions on the activities of grazing animals (Figure 1).

A positive correlation was verified between the sward height and bite depth ($r = 0.97$, $p < 0.0001$), i.e., the higher the canopy height the greater the bite depth (Figure 2).

In general, the bite depth has a positive linear relationship with sward height, but it is noteworthy that the greater the grazed depth does not necessarily means greater depth per bite, since all the animals remained several hours on grazing, all the tillers have been probably grazed more than once.

The bite depth ranged from 45.92 to 70.63% of the height of the extended tiller, higher than recommended by Hodgson et al. (1994), which corresponds to a relatively constant value of the height of the extended tiller (around 50%) or of the height of canopy intact (around 35%).

This greater removal was probably due to the great portion of potentially edible pasture (Table 1), layer represented by green leaves at the top of the sward canopy, indicating that there were no physical constraints to ingestion, imposed by canopy structure, characterized by increase in fractions of stem and sheath, which hinder the efficiency in the seizing of food by the animal.

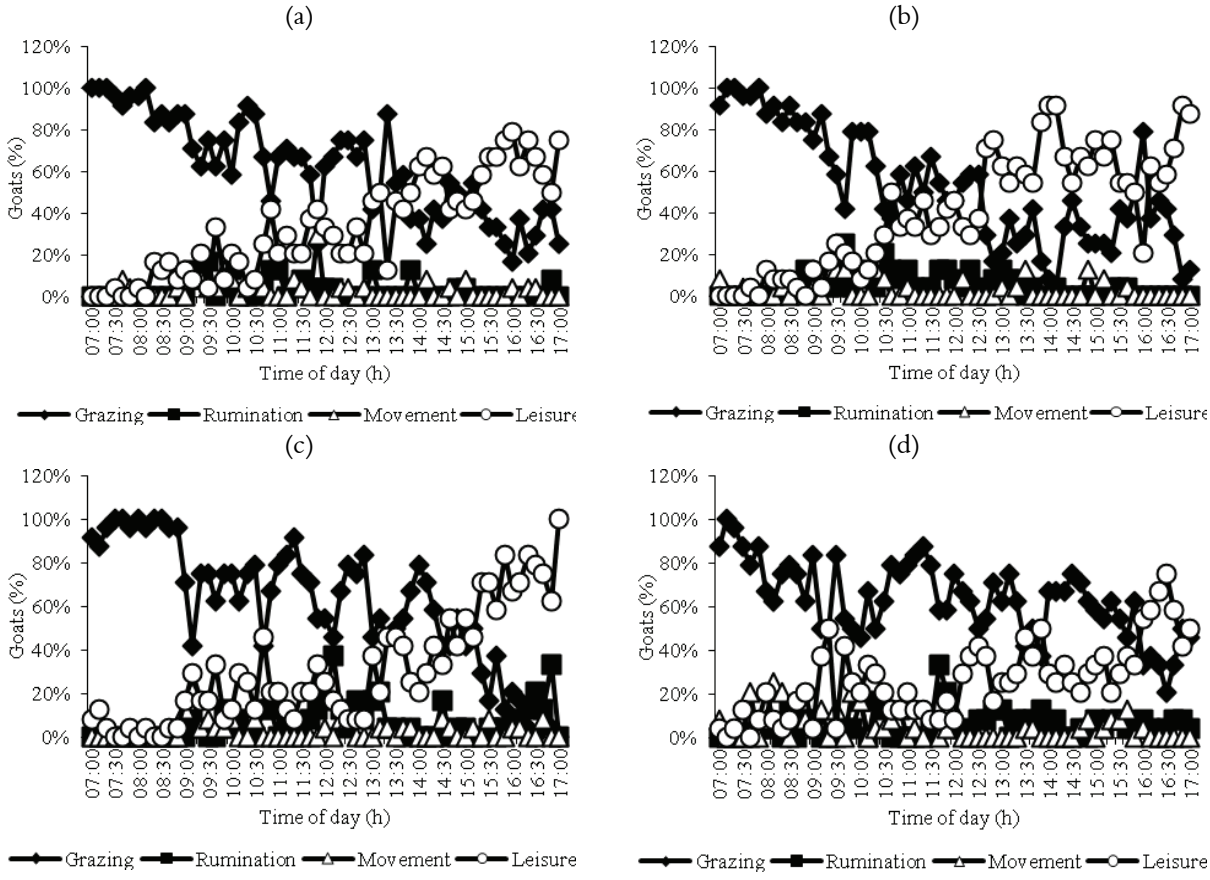

Figure 1. Behavior variables of Anglo Nubian goats grazing on Tanzania-grass pasture with 30 (a), 50 (b), 70 (c) and 90 cm (d) of height.

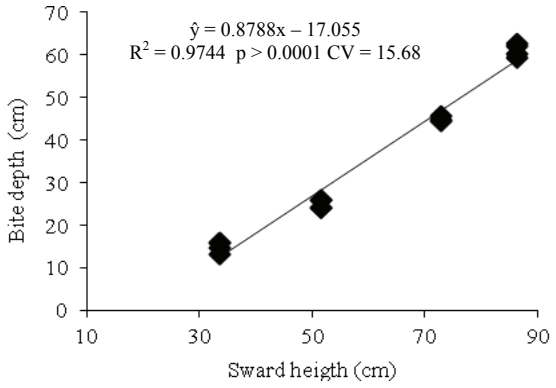

Figure 2. Bite depth by goats on Tanzania-grass pasture with different heights.

Several studies analyzing the goat behavior on forage grass pastures found a linear relationship between the tiller height and the bite depth, with the defoliation of the extended tiller.

The total forage mass consumed and the ingestion rate presented a cubic function in relation to the sward height, with higher values for the height of 50 cm (Figure 3), when the animals had opportunities to eat in adequate quality and quantity, without intake restrictions, reflecting in shorter time spent on grazing (Table 2, Figure 1).

Above 50 cm of canopy height, there was a reduction in ingestion rate, probably because in the pastures with higher heights, the processes of search, seizing and handling of the bite, and the movement within the environment, become more difficult. The ingestion rate increased with the rise in canopy height up to a maximum level (50 cm), after which the increase in height resulted in reduced ingestion rate, reflecting in lower forage intake. In cattle, Palhano et al. (2007) observed increase in the ingestion rate of mombaça-grass up to the canopy height of 100 cm, when the rate decreased, reflecting in a lower total consumption of forage, which may be due to sparse arrangement of leaves at higher canopy strata.

The bite rate was linearly reduced with rising canopy height, from 48 to 23 bites minute^{-1} between the lowest and highest assessed height (Figure 4). At lower heights, the animals compensated the lower forage mass and smaller bite depth by increasing the number of bites. When the sward height is greater, the animal requires longer time of seizing and chewing leaf blades, reducing the bite rate. This result corroborates Burns and Sollenberger (2002) stating that the bite rate is influenced by the forage mass and canopy height.

The time per bite, by being the inverse of bite rate, increased linearly with the raise in canopy height (Figure 4), this can be explained by the longer time spent to form and handle the bite in higher pasture heights. The time to form the bite varied between 1.24 and 2.64 seconds, i.e., there was an increase of over 100% in time to perform each bite, between the lowest and highest assessed height, similarly to Palhano et al. (2007) that evaluated heifers grazing on mombaça-grass pastures with different heights, with a variation between 1.95 and 3.99 seconds. The results for the daily intake revealed a cubic trend in relation to the canopy height (Figure 5).

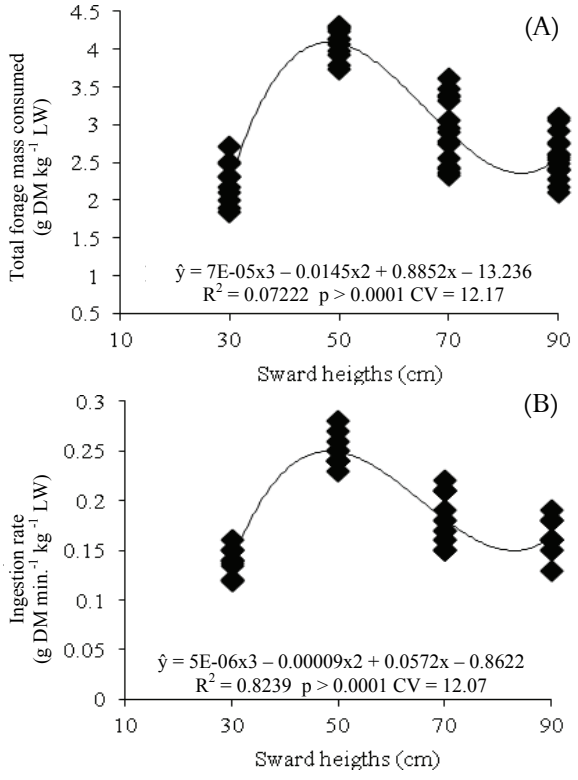

Figure 3. Total forage mass consumed (A) and ingestion rate (B) of Anglo Nubian goats grazing on Tanzania-grass pasture with different heights.

With 30 cm of canopy height, situation of low forage mass, the DM intake was lower than in the other treatments, indicating a restraint to the selection process by the animals. On the other hand, at 70 and 90 cm, the sward height hindered the seizing and intake of forage, as previously mentioned. Furthermore, the increase in height causes a reduction in the quality of the pasture and its nutritional value, in terms of in vitro digestibility of DM and crude protein, and of mineral levels, with a decrease in the content of crude protein and an increase in fiber levels, both in leaf blades and stems (CANO et al., 2004; REGO et al., 2003). Although the grazing time had been shorter at 50 cm (Table 2, Figure 1), the high ingestion rates optimized the use of time spent on grazing, resulting in higher daily intake.

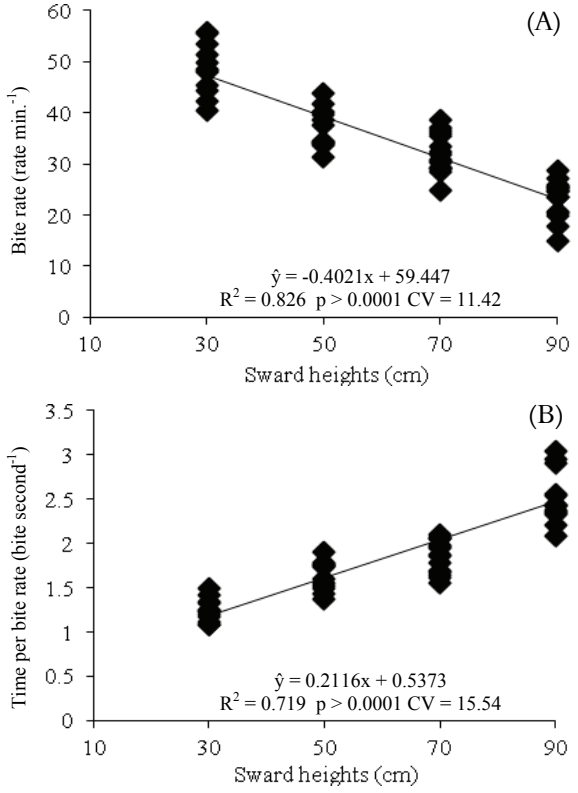

Figure 4. Bite rate (A) and time per bite (B) of Anglo Nubian goats grazing on Tanzania-grass pasture with different heights.

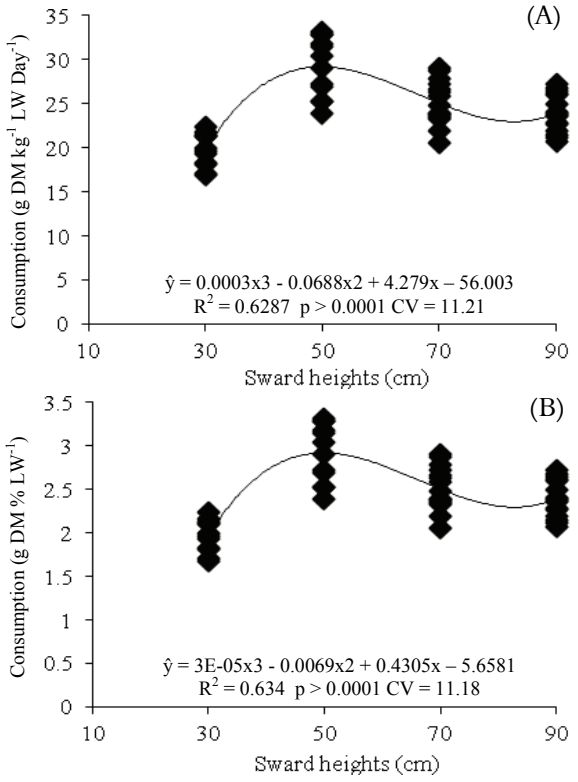

Figure 5. Consumption in g DM kg^{-1} LW day^{-1} (A) and g DM $\%LW^{-1}$ (B) of Anglo Nubian goats grazing on Tanzania-grass pasture with different heights.

Conclusion

The management of sward height influences the characteristics of forage canopy and behavior of grazing animals. In this case, aiming at the achievement of satisfactory yields of forage and leaf mass, associated with a shorter grazing time and greater intake of forage by goats, the Tanzania-grass pasture should be managed at 50 cm height, allowing these animals to capture effectively the forage.

References

BARBOSA, R. A.; NASCIMENTO JUNIOR, D.; EUCLIDES, V. P. B.; SILVA, S. C.; ZIMMER, A. H.; TORRES JÚNIOR, A. A. Capim-tanzânia submetido a combinações entre intensidade e freqüência de pastejo. **Pesquisa Agropecuária Brasileira**, v. 42, n. 3, p. 329-340, 2007.

BARROS, C. S.; DITTRICH, J. R.; ROCHA, C. Comportamento de caprinos em pasto de *Brachiaria hibrida* cv. mulato. **Revista da Faculdade de Veterinária, Zootecnia e Agronomia (PUCRS – Uruguaiana)**, v. 14, n. 2, p. 187-206, 2007.

BURNS, J. C.; SOLLENBERGER, L. E. Grazing behavior of ruminants and daily performance from warm season grasses. **Crop Science**, v. 42, n. 3, p. 873-881, 2002.

CANO, C. C. P.; CECATO, U.; CANTO, M. W.; RODRIGUES, A. B.; JOBIM, C. C.; RODRIGUES, A. M.; GALBEIRO, S.; NASCIMENTO, W. G. Produção de forragem do Capim-Tanzânia (*Panicummaximum* Jacq. cv. Tanzânia-1) pastejado em diferentes alturas. **Revista Brasileira de Zootecnia**, v. 33, n. 6, p. 1949-1958, 2004. (Suplemento 2).

CARNEVALLI, R. A.; DA SILVA, S. C.; CARVALHO, C. A. B.; SBRISSIA, A. F.; FAGUNDES, J. L.; PINTO, L. F. M.; PEDREIRA, C. G. S. Desempenho de ovinos e respostas de pastagens de Coastcross submetidas a regimes de desfolha sob lotação contínua. **Pesquisa Agropecuária Brasileira**, v. 36, n. 6, p. 919-927, 2001a.

CARNEVALLI, R. A.; DA SILVA, S. C.; FAGUNDES, F. L.; SBRISSIA, A. F.; CARVALHO, C. A. B.; PINTO, L. F. M.; PEDREIRA, C. G. S. Desempenho de ovinos e respostas de pastagens de Tifton-85 (*Cynodon* spp.) sob lotação contínua. **Scientia Agricola**, v. 58, n. 1, p. 7-15, 2001b.

CARNEVALLI, R. A.; SILVA, S. C.; BUENO, A. A. O.; UEBELE, M. C.; HODGSON, J.; SILVA, G. N.; MORAIS, J. P. G. Herbage production and grazing losses in *Panicum maximum* cv. Mombaça under four grazing managements. **Tropical Grasslands**, v. 40, n. 3, p. 65-176, 2006.

FAGUNDES, J. L.; SILVA, S. C.; PEDREIRA, C. G. S.; CARNEVALLI, R. A.; CARVALHO, C. A. B.; SBRISSIA, A. F.; PINTO, L. F. M. Intensidades de pastejo e a composição morfológica de pastos de *Cynodon* spp. **Scientia Agricola**, v. 56, n. 4, p. 897-908, 1999.

GOMIDE, C. A. M.; GOMIDE, J. A.; ALEXANDRINO, E. Características estruturais e produção de forragem em pastos de capim-mombaça submetidos a períodos de descanso. **Pesquisa Agropecuária Brasileira**, v. 42, n. 10, p. 1487-1494, 2007.

GONÇALVES, E. N.; CARVALHO, P. C. F.; KUNRATH, T. R.; CARASSAI, I. J.; BREMM, C.; FISCHER, V. Relações planta-animal em ambiente pastoril heterogêneo: processo de ingestão de forragem. **Revista Brasileira de Zootecnia**, v. 38, n. 9, p. 1655-1662, 2009.

HODGSON, J.; CLARK, D. A.; MITCHELL, R. J. Foraging behaviour in grazing animals and its impact on plant communities. In: FAHEY, G. C. (Ed.). **Forage quality evaluation and utilization**. National Conference on Forage Quality. Lincoln: American Society of Agronomy, 1994. p. 796-827.

MARCELINO, K. R. A.; NASCIMENTO JÚNIOR, D.; DA SILVA, S. C., EUCLIDES, V. P. B.; FONSECA, D. M. Características morfogênicas e estruturais e produção de forragem do capim-marandu submetido a intensidades e freqüências de desfolhação. **Revista Brasileira de Zootecnia**, v. 35, n. 6, p. 2243-2252, 2006.

MARTHA JÚNIOR, G. B.; CORSI, M.; BARIONI, L. G.; VILELA, L. Intensidade de desfolha e produção de forragem irrigado na primavera e no verão. **Pesquisa Agropecuária Brasileira**, v. 39, n. 9, p. 927-936, 2004.

PALHANO, A. L.; CARVALHO, P. C. F.; DITTRICH, J. R.; MORAIS, A.; SILVA, S. C.; MONTEIRO, A. L. G. Características do processo de ingestão de forragem por novilhas holandesas em pastagens de capim-mombaça. **Revista Brasileira de Zootecnia**, v. 36, n. 4, p. 1014-1021, 2007. (Suplemento).

PARENTE, H. N.; SANTOS, E. M.; ZANINE, A. M.; OLIVEIRA, J. S.; FERREIRA, D. J. Hábito de pastejo de caprinos da raça saanen em pastagem de tifton-85 (cynodonssp). **Revista da Faculdade de Veterinária Zootecnia e Agronomia (PUCRS – Uruguaiana)**, v. 12, n. 1, p. 143-155, 2005.

PENNING, P. D.; HOOPER, G. E. N. A evaluation of the use of shortterm weight changes in grazing sheep for estimating herbage intake. **Grass and Forage Science**, v. 40, n. 1, p. 79-84, 1985.

POMPEU, R. C. F. F.; CÂNDIDO, M. J. D.; NEIVA, J. N. M.; ROGÉRIO, M. C. P.; FACÓ, O. Comportamento da biomassa pré-pastejo e pós- pastejo de capim-tanzânia sob lotação rotativa com quatro níveis de suplementação concentrado. **Revista Brasileira de Zootecnia**, v. 37, n. 3, p. 383-393, 2008.

REGO, F. C. A.; CECATO, U.; CANTO, M. C. Densidade e qualidade dos estratos de forragem do capim Tanzânia (*Panicum maximum* Jacq.) manejado em diferentes alturas, sob pastejo. **Acta Scientiarum**, v. 23, n. 4, p. 801-807, 2001.

REGO, F. C. A.; CECATO, U.; DAMASCENO, J. C.; RIBAS, N. P.; SANTOS, G. T.; MOREIRA, F. B.; RODRIGUES, A. M. Valor nutritivo do capim-Tanzânia (*Panicum maximum* Jacq cv. Tanzânia-1) manejado em alturas de pastejo. **Acta Scientiarum**, v. 25, n. 2, p. 363-370, 2003.

REGO, F. C. A.; DAMASCENO, J. C.; FUKUMOTO, N. M.; CORTÊS, C.; HOESHI, L.; MARTINS, E. N.; CECATO, U. Comportamentoingestivo de novilhos mestiços em pastagens tropicais manejadas em diferentes alturas. **Revista Brasileira de Zootecnia**, v. 35, n. 4, p. 1611-1620, 2006. (Suplemento).

SAS-Statistical Analisys System. **Statistical analisys system user's guide**: statistic. Version 8. Cary: Statistical Analysis System Institute, 2000.

SBRISSIA, A. F.; DA SILVA, S. C.; CARVALHO, C. A. B.; MATTHEW, C.; CARNEVALLI, L. P.; PINTO, L. F. M.; FAGUNDES, J. L.; PEDREIRA, G. S. Tiller siza/population density compensation in Coastcross grazed swards. **Scientia Agricola**, v. 58, n. 4, p. 655-665, 2001.

SBRISSIA, A. F.; DA SILVA, S. C.; MATTHEW, C.; CARVALHO, C. A. B.; CARNEVALLI, R. A.; PINTO, L. F. M.; FAGUNDES, J. L.; PEDREIRA, C. G. S. Tiller size/density compensation in grazed Tifton 85 bermuda grass swards. **Pesquisa Agropecuária Brasileira**, v. 38, n. 12, p. 1459-1468, 2003.

SILVA, S. C.; NASCIMENTO JÚNIOR, D. Avanços na pesquisa com plantas forrageiras tropicais em pastagens: características morfofisiológicas e manejo do pastejo. **Revista Brasileira de Zootecnia**, v. 36, suplemento especial, p. 121-138, 2007.

SILVA, R. G.; CÂNDIDO, M. J. D.; NEIVA, J. N. M.; LÔBOR, N. B.; SILVA, D. S. Características estruturais do dossel de pastagens de capim-tanzânia mantidas sob três períodos de descanso com ovinos. **Revista Brasileira de Zootecnia**, v. 36, n. 5, p. 1255-1265, 2007.

UNGAR, E. D. Ingestivebehaviour. In: HODGSON, J.; ILLIUS, A. (Ed.). **The ecology and management of grazing systems**. Wallingford: CABI, 1996. p. 185-218.

Received on August 22, 2011.
Accepted on November 28, 2011.